UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest and Alaska Fisheries Center
Resource Assessment and Conservation
Engineering

November 24, 1980 F/NWC1:RB

CRUISE RESULTS

Cruise No. OR-79-02 NOAA R/V Oregon
Cruise No. P-79-01 FV Paragon II
Cruise No. DB-79-02 FV Discovery Bay

INTRODUCTORY NOTE

The crab-groundfish survey was expanded in 1979 to extensively survey the fishery resources of the eastern Bering Sea. Intensive surveys of this type are planned at 3-year intervals with smaller-scale surveys planned in intervening years.

The 1979 survey was also a cooperative effort with the Far Seas Fisheries Research Laboratory of Shimizu, Japan. The Far Seas Laboratory used two chartered commercial fishing vessels to survey much the same area as the U.S. vessels with the exception that the depth range surveyed by Japanese vessels was from about 40-1000 m, whereas U.S. vessels surveyed waters from about 20-750 m. Survey data from the U.S. and Japanese vessels will eventually be combined into a single data base. Comparative fishing experiments were conducted during the survey to provide fishing power comparisons between the U.S. and Japanese vessels.

In addition, the NOAA RV Miller Freeman participated in the survey to sample the off-bottom component of the pollock population using hydroacoustic and mid-water trawling techniques. These results will be used to supplement information from the demersal trawl survey by U.S. and Japanese vessels.

It should also be noted that an independent survey of the fishery resources of Norton Sound was concluded in August by the NOAA RV Miller Freeman. This

will allow the survey results from the eastern Bering Sea to be extended northward to cover the Norton Sound region.

These cruise results will only cover the survey activities of the Discovery Bay, Oregon, and Paragon II in the eastern Bering Sea.

CRUISE PERIOD

Oregon - May 20 - August 27

Paragon II - May 17 - August 21

Discovery Bay - July 3 - August 24

ITINERARY

The Oregon departed Kodiak on May 20th and returned to Dutch Harbor on August 27th to complete survey activities. Scheduled port calls were made at Dutch Harbor on June 4-7, June 24-29, July 15-19, and August 6-9 for exchange of scientific personnel and resupply of the vessel. A number of unscheduled port calls were made at Dutch Harbor for discharging a sick crewman and for vessel repairs.

The Paragon II departed Kodiak on May 17th and returned to Dutch Harbor on August 21st at the completion of survey activities. Port calls were made at Dutch Harbor on June 9, July 3, and July 26 for exchange of scientific personnel.

The Discovery Bay Departed Dutch Harbor on July 3rd and ended survey activity at Dutch Harbor on August 24th. Scientific personnel were exchanged on July 27-28 at Dutch Harbor.

AREA SURVEYED

The geographical area of the 1979 crab-groundfish survey was more extensive than has previously been covered by a single survey in the eastern Bering Sea. The area surveyed by NWAFC vessels extended from Unimak Pass and the Alaska Peninsula north to the latitude of St. Lawrence Island and from nearshore waters of the Alaskan coast to depths of 750 m on the continental slope (Figure 1).

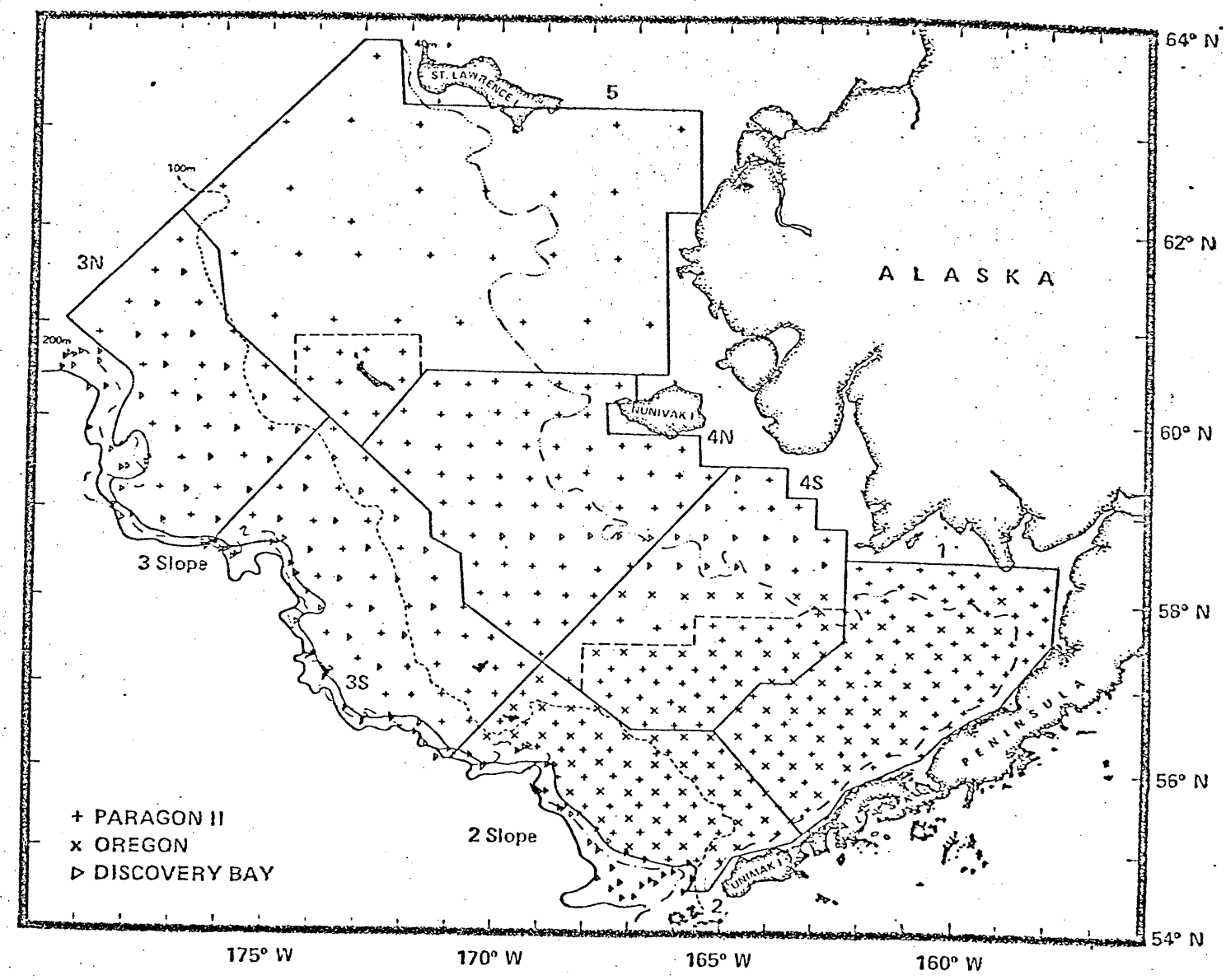

Figure 1.--Stations sampled by NWAFC research vessels, May-August, 1979.

The region between St. Matthew and Nunivak Islands and St. Lawrence Island had not previously been surveyed systematically. The Oregon surveyed most of the comparative fishing area in the southeastern Bering Sea (Subareas 1 and 2 and parts of 3S and 4S) which has been surveyed annually by the Oregon since 1971 to provide annual assessment data for crabs and various species of groundfish. The Paragon II surveyed virtually the entire continental shelf region either solely or in conjunction with the other two vessels. The Discovery Bay covered the northwest portion of the continental shelf (subareas 3S and 3N) with the Paragon II and conducted all of the sampling on the continental slope.

PRIMARY OBJECTIVES

1. To provide a continuing annual assessment of crab and groundfish resources of the eastern Bering Sea.

2. To study long-term changes in the demersal fish and invertebrate community of the eastern Bering Sea by relating results of the 1979 survey to results of a similar large-scale survey in 1975 and future large-scale studies at three-year intervals.

3. To measure selected oceanographic parameters which may affect the abundance and distribution of these populations.

4. To initiate studies of demersal fish and invertebrate resources of the continental slope between 200-1000 m.

5. To expand the 1979 U.S. data base by incorporating results of Japanese research surveys.

6. To conduct side-by-side and "tail attack" (one vessel towing directly behind the other) trawling experiments to provide fishing power comparisons between U.S. and Japanese vessels participating in the survey and to assess the adequacy of these methods.

7. To continue feasibility studies on assessing the year-class strength of juvenile pollock and juveniles of other species.

SECONDARY OBJECTIVES

1. To collect morphometric and biological data on blue king crab (Paralithodes platypus) and hair crab (Erimacrus isenbeckii).

2. To collect specimens of fish and invertebrates for reference collections of various institutions.

3. To collect samples of yellowfin sole, pollock, sablefish, and rockfish and other species for genetic studies.

4. To photograph demersal fish and invertebrates.

5. To collect fecundity and maturity samples from pollock.

6. To assess the Marinovich midwater trawl for sampling juvenile pollock.

GEAR

The gear used by all vessels surveying continental shelf waters was the standard 400-mesh eastern otter trawl with a footrope length of 94 feet (28.7 m) and headrope length of 71 feet (21.6 m). Mesh sizes in the wing and body were 4-inch (102 mm) and in the intermediate and codend 3.5-inch (89 mm); the codend had a 1.25-mesh (32 mm) liner. The net was rigged with 15 8-inch (203 mm) floats on the headrope and dandylines were 25 fathoms (45.5 m) including 10 fathom (18.2 m) bridles. The footrope was not weighted with chain. Otter doors were 5 x 7 foot (1.5 x 2.1 m) Astoria "V" doors. While fishing, the wing spread was measured at 50-51.3 feet (15.2-15.6 m) and the vertical opening at 5-6 feet (1.5-1.8 m).

In continental slope waters surveyed by the Discovery Bay, a Nor'eastern trawl was used equipped with roller gear having 14- to 18-inch (346-457 mm) bobbins. The Nor'eastern trawl had a footrope length of 105 feet (32.0 m) and a headrope length of 90 feet (27.4 m) and was rigged with 22 13-inch (330 mm) floats on the headrope. The body of net was constructed of 5-inch (127 m) mesh, the intermediate and codend of 3.5-inch (89 mm) mesh, and the codend had a liner of 1.25-inch (32 mm) mesh. The net was fished with 3 30 fathom (54.9 m) dandylines from each wing and 6 x 9 feet (1.8 x 2.7 m) doors. The mean effective path width of the Nor'eastern trawl has been measured while fishing at 44 feet (13.4 m) and the mean vertical opening at 30 feet (9.2 m).

In addition to the bottom trawling carried out at standard survey stations, experimental mid-water trawling was carried out intermittently to assess mid-water trawling techniques for sampling juvenile pollock. The trawl used was a Marinovich trawl with a 30-foot (9.1 m) headrope and footrope and 3-inch (76 mm) mesh in the dogears and square, 2.5-inch (64 mm) mesh in the belly, 2-inch (51 mm) mesh in the body, 1.5-inch (38 mm) mesh in the funnel, 1.25-inch (32 mm) mesh in the intermediate and codend with a 0.5-inch (13 mm) mesh liner in the intermediate and codend. The trawl was rigged with 28 8-inch (203 mm) floats and 80 pounds (36 kg) of chain on each end of the footrope. Dandylines were 10 fathoms (18 m) and doors were 5 x 7 foot (1.5 x 2.1 m) Astoria "V" doors.

METHODS

The survey was designed to comprehensively sample the distribution of all commercially important demersal fish and crabs over the continental shelf and slope (to 750 m) of the eastern Bering Sea. The station pattern was based on the standard 20 x 20 nautical mile grid (1 station per 400 square miles) that has been used in past trawl surveys in the eastern Bering Sea with higher density sampling (1 station per 250 square miles) in subareas 1, 2, and 3 where

concentrations of commercially important crab and demersal fish are highest. Station density in the northernmost subarea (subarea 5) where concentrations of fish and shellfish is light was the lowest (1 station per 1600 square miles) except around St. Matthew Island where density was increased to provide better sampling of the Blue king crab resource in this area. Sampling on the continental slope was planned along 50 transects of 5 stations each located at approximate depths of 200, 300, 400, 500, and 750 m. Because of delays caused by weather and equipment breakdowns, actual sampling densities were reduced in some areas. In subarea 3, sampling density was reduced to 1 station per 400 square miles, and on the slope only 3 depths (200, 500, and 750 m) were sampled on track lines. As anticipated, some of the track lines on the slope could not be completely sampled because of untrawlable bottom.

Half-hour tows were made at each survey station. Station sampling procedures included the collection of echosounder tapes and the release of XBT probes at each station to obtain temperature profiles.

Catches were entirely processed at all stations if they were less than approximately 2500 pounds (1100 kg), or in the case of larger catches, subsampling techniques were used to reduce the processed portion to 2500 pounds or less. However, all crabs were removed from the entire catch regardless of its size. All king and Tanner crab were sorted by species and sex, and the weight and numbers in each species-sex category determined. Lengths, widths, shell condition, egg condition, and fullness of the egg clutch were also determined from all crabs in the catch or from a random subsample of the total catch.

All groundfish were sorted by species with weights, and in most cases, numbers of each species determined. For commercially important species, length-frequency data were taken from each haul. Age structure samples, stratified by sex and centimeter size categories, were also taken for commercially important species.

Three methods were used to compare the fishing power of the individual U.S. and Japanese vessels. One method involved having two of the U.S. vessels fish alternate rows of stations in certain subareas from which mean catch rates for the vessel could be compared. The Oregon and Paragon II fished alternate rows of stations in subareas 1 and 2, and the Discovery Bay and Paragon II fished alternate rows of stations in subarea 3. The second method used was side-by-side trawling which was conducted by the Oregon and Discovery Bay and between the Discovery Bay and one of the Japanese vessels. Side-by-side trawling between the Oregon and Paragon II was conducted in 1978. The third method used in 1979 was the "alternate tail attack" method involving the Oregon and one of the Japanese groundfish research vessels and the Japanese crab research vessel. This method consisted of one vessel towing directly behind the other with the vessels alternating positions. The "tail attack" method was designed by Japanese scientists, and they will analyze results from these experiments for both Tanner crab and groundfish.

RESULTS OF NWAFC SURVEY FOR DEMERSAL FISH

The three NWAFC vessels trawled 596 survey stations of which 11 tows were unsatisfactory (Table 1). An additional 77 comparative tows were completed by the Oregon and Discovery Bay with Japanese vessels; four of the 77 tows were unsatisfactory. Seven mid-water and 2 shrimp tows were also completed by the Paragon II. The three vessels averaged 2.9 tows per day based on scheduled at-sea days.

Tabl 1.--Number of hauls completed by vessel and surv subarea during the 1979 crab-groundfish survey.

Strata	OREGON		DISCOVERY BAY		PARAGON II		Totals	
	Standard tows	Comparative or other tows	Standard tows	Comparative or other tows	Standard tows	Comparative or other tows	Standard tows	Comparativ or other t
1	40	8	0	8	89	0	129	16
2	42	11	0	14	44	1	86	26
3S	6	35	18	0	37	5	61	40
3N	0	0	20	0	21	0	41	0
4S	23	0	13	0	39	0	75	0
4N	0	0	7	0	62	2	69	2
5	0	0	0	0	38	1	38	1
2 Slope	0	0	37	1	0	0	37	1
3 Slope	0	0	60	0	0	0	60	0
Totals	111	54	155	23	330	9	596	86
Number unsatisfactory tows	0	4	5	0	6	0	11	4
Scheduled days on grounds	90		52		92		234	
Number tows per day	1.8		3.4		3.7		2.9	

For demersal fish, weights, and in most cases, numbers were determined for all species from each haul. For commercially important species or potentially important commercial species, length frequency data and age structure samples were collected. A total of 226,821 fish were measured (Table 2); over half of this total consisted of pollock (79,352) and yellowfin sole (59,095). Over half the age structure samples were also from pollock and yellowfin sole with a total of 6,264 otoliths or scales collected from all species. As can be noted in Table 2, no age structures were collected for some of the commercially important flounders, but these were collected on Japanese research vessels as part of the cooperative arrangements.

Distributions and relative abundance of pollock and yellowfin sole during the survey are illustrated in Figures 2 and 3. Pollock were distributed throughout most of the survey area with relatively high catch rates (>3000 lbs/hr) widely distributed over the outer continental shelf and slope and extending onto the inner shelf. Yellowfin sole were primarily limited to the inner shelf, as is typical of the summer distribution of this species. There was an extremely broad distribution of high catch rates (>1200 lbs/hr) of yellowfin sole extending from the Alaska Peninsula northward to the latitude of Nunivak Island. Marked changes in distribution of these species were apparent in 1979, compared to their distribution during the large-scale survey in August-October 1975. The distribution of pollock shows a much wider distribution of high catch rates and a much greater extension of medium to high catch rates onto the inner shelf during the 1979 survey than during the 1975 survey. In 1975, the distribution of high catch rates of yellowfin sole was limited to the southeastern Bering Sea, whereas in 1979, these high catch rates extended northwest of the southeastern Bering Sea. The abundance of yellowfin sole is known to have increased since 1975. Temperature conditions in the eastern Bering Sea in 1979 were warmer than in 1975 and may account, at least in part for the observed differences in distribution, particularly for pollock.

Table 2.--Numbers of fish measured and age structures collected during the 1979 crab-groundfish survey.

	Number Measured	Number age structures collected (approximate)
Pollock	79,352	2,666
Yellowfin sole	59,095	1,139
Pacific cod	19,493	777
Greenland turbot	15,956	0
Flathead sole	11,998	0
Rock sole	11,549	452
Alaska plaice	8,499	0
Saffron cod	5,210	279
Arrowtooth flounder	4,951	0
Longhead dab	2,758	0
Pacific herring	1,781	0
Pacific halibut	1,530	0
Rainbow smelt	1,087	0
Sablefish	836	45
Pacific ocean perch	670	234
Rattail (*C. cinerus*)	645	265
Rattail (*C. pectoralis*)	501	173
Arctic cod	288	0
Thornyhead rockfish	204	181
Rainbow smelt	192	0
Starry flounder	87	0
Shortrackor rockfish	57	53
Rex sole	55	0
Dusky rockfish	27	0
TOTAL	226,821	6,264

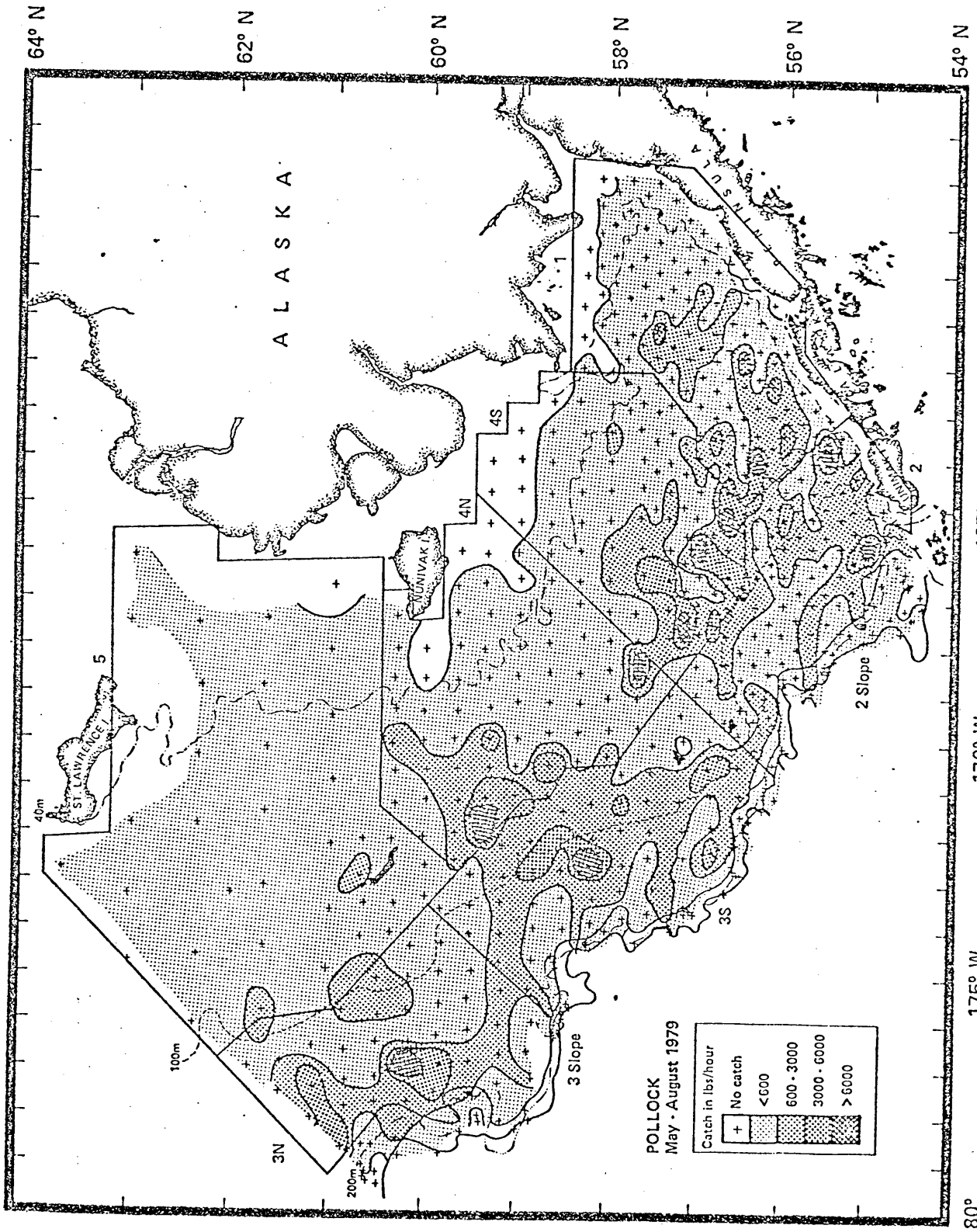

Figure 2.--Distribution and relative abundance of pollock as shown by the NWAFC trawl survey May-August 1979.

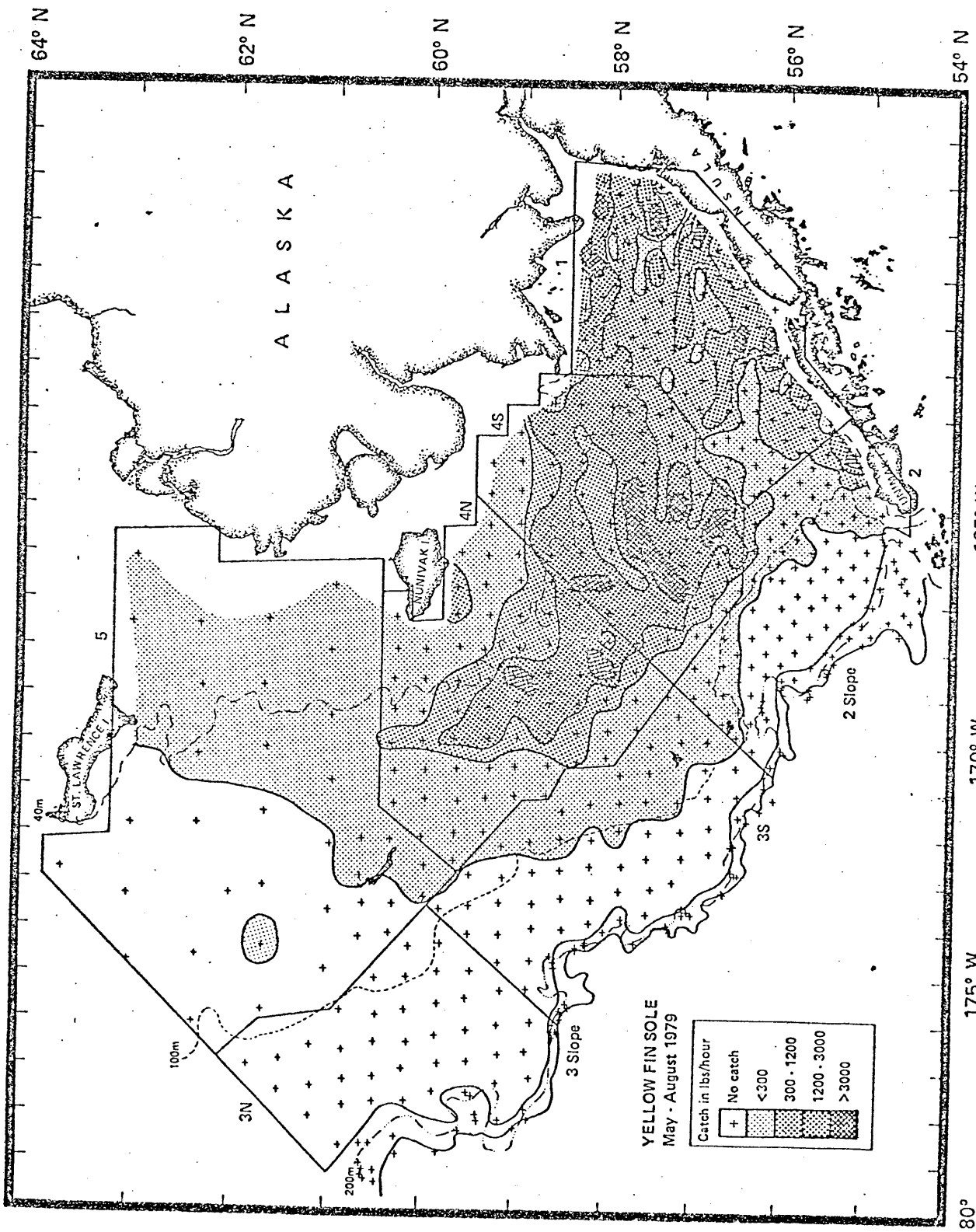

Figure 3.--Distribution and relative abundance of yellowfin sole as shown by the NWAFC trawl survey, May-August 1979.

SECONDARY PROJECTS

1. Numerous collections of invertebrates and fishes were collected by guest biologists or NWAFC biologists for the University of Washington College of Fisheries, the Smithsonian Institute, the NMFS Systematics Laboratory in Washington, D.C., Oregon State University, and the British Columbia Provincial Museum.

2. For genetic studies, samples were collected of approximately 400 yellowfin sole, 250 pollock, 207 Pacific ocean perch, 30 other rockfish, 50 Greenland turbot, 50 arrowtooth flounder, and 60 sablefish.

3. Pollock ovaries and age structures, accompanied by fish weights and lengths and ovary weights were collected at several locations and time periods for fecundity and mortality studies.

4. Seven mid-water tows were completed to assess the Marinovich Mid-water Trawl for sampling juvenile pollock.

5. Echosounder records were collected at most stations by the Paragon II and Discovery Bay to study the horizontal and vertical distribution of juvenile pollock.

PERSONNEL

Vessel captains during the survey were Perry Buholm on the Oregon, Erling Jacobson and Charlie Jacobson on the Paragon II, and Otto Nordtvit on the Discovery Bay. A relatively large number of guest scientists also participated in the survey. They came from Clark College, Georgia, the Virginia Institute of Marine Science, Smithsonian Institute, NMFS, Washington, D.C., and the University of Washington. This proved to be a very satisfactory arrangement. The guests fully participated in the regular survey work, but also had an opportunity to collect specimens for their respective institutions.

Scientific personnel during the survey were as follows: OREGON

Leg	Field Party Chief	Other Personnel
1	B. Otto, Kodiak	R. Bakkala, Seattle F. Wathne, Seattle C. Pace, Kodiak
2	J. Bowerman, Kodiak	K. Niggol, Seattle C. Pace, Kodiak V. Scholey, Seattle
3	D. Kessler, Kodiak	B. Patten, Seattle S. Wilson, Seattle A. Fukuyama, Kodiak
4	B. Otto, Kodiak	C. Rose, Seattle M. Bohle, Seattle A. Rodriquiz, Seattle
5	K. Niggol, Seattle	A. Fukuyama, Kodiak F. Munk, Kodiak D. Nelson*, Seattle

* Guest Biologist

PARAGON II

Leg	Field Party Chief	Other Personnel
1	R. MacIntosh, Kodiak	W. Hirschberger, Seattle M. Bohle, Seattle J. June, Seattle J. Koczur, Kodiak
2	R. Wolotira, Kodiak	T. Sample, Seattle L. Pokryfki, Seattle D. Killebrew, Seattle G. Hudkins, Seattle
3	G. Smith, Seattle	S. Lazarus, Kodiak T. Armetta, Kodiak J. Rosapepe, Seattle J. Finan*, Washington, D.C.
4	K. King, Seattle	T. Armetta, Kodiak K. Falsone, Seattle V. Scholey, Seattle J. Coffin, Seattle

DISCOVERY BAY

Leg	Field Party Chief	Other Personnel
1	W. Hirschberger, Seattle	C. Pace, Kodiak L. Ong*, Washington, D.C. J. Ross*, Washington, D.C. M. Lynde*, Seattle
2	P. Raymore, Seattle	D. Lipton*, Washington, D.C. S. Sears*, Atlanta, Georgia J. Rosapepe, Seattle

* Guest biologist